federal register

Tuesday
August 12, 1980

Part IV

Department of Energy

Office of Conservation and Solar Energy

Energy Conservation Program for Consumer Products; Test Procedures for Furnaces

DEPARTMENT OF ENERGY

Office of Conservation and Solar Energy

10 CFR Part 430

Energy Conservation Program for Consumer Products; Final Rulemaking Regarding Amendments to Test Procedures for Furnaces

AGENCY: Department of Energy.

ACTION: Final rule.

SUMMARY: The Department of Energy (DOE) hereby prescribes amendments to its test procedures for furnaces. The purpose of these amendments is to include test procedures for pulse combustion and condensing furnaces and to include certain technical revisions. These test procedures are part of the energy conservation program for consumer products established pursuant to the Energy Policy and Conservation Act, as amended by the National Energy Conservation Policy Act. Among other program elements, the legislation requires that standard methods of testing be prescribed for covered products.

EFFECTIVE DATE: September 11, 1980.

FOR FURTHER INFORMATION CONTACT: James A. Smith, U.S. Department of Energy, Office of Conservation and Solar Energy, Division of Buildings and Community Systems, Consumer Products Efficiency Branch, Room GH-065, Mail Stop 6B-025, Forrestal Building, 1000 Independence Avenue, S.W., Washington, D.C. 20585, (202) 252-9127. Eugene Margolis, U.S. Department of Energy, Office of General Counsel, Room 1E-254, Mail Stop 6A-152, Forrestal Building, 1000 Independence Avenue, S.W., Washington, D.C. 20585, (202) 252-9510.

SUPPLEMENTARY INFORMATION:

A. Background

On October 1, 1977, the Department of Energy (DOE) assumed the authority of the Federal Energy Administration (FEA) for the energy conservation program for consumer products, pursuant to Section 301 of the Department of Energy Organization Act (DOE Act) (Pub. L. 95-51). The energy conservation program for consumer products was established by FEA pursuant to Title III, Part B of the Energy Policy and Conservation Act (Act) (Pub. L. 94-163).[1] Section 323 (42 U.S.C. 6293) of the Act requires that standard methods of testing be prescribed for covered products. Test procedures appear at 10 CFR Part 430, Subpart B.

Test procedures for furnaces were originally proposed by notice issued August 11, 1977 (42 FR 40826). Public hearings on the proposed test procedures were held on October 4, 1977. A final rule was published May 10, 1978 (43 FR 20147).

On May 29, 1979 (44 FR 30978), DOE published an advance notice of proposed rulemaking which invited interested persons to present written data, views and arguments with respect to the need for amending DOE's test procedures for furnaces in order to address any areas which interested persons felt should be expanded or changed, and to include in the test procedures two new furnace designs, pulse combustion furnaces and condensing furnaces.

DOE has learned that some manufacturers, through the experience of testing, have identified areas of concern in the test procedures which they feel should be expanded or changed. A number of such areas of concern have been the subject of applications for exception to DOE's Office of Hearings and Appeals (OHA) and the findings of OHA are available from the Public Docket Room, Room B210, 2000 M St., Washington, D.C. 20461, Monday through Friday 1:00 p.m. to 5:00 p.m. On the basis of information submitted with applications to OHA, comments submitted in response to the advance notice, and other available information, DOE published a proposed rule to amend its test procedures for furnaces on January 4, 1980 (45 FR 1298). Subsequently, a hearing was held on February 27, 1980 and comments were received regarding the proposed rule.

B. Discussion of Comments

Comments were received from industry, trade associations and members of the public. The major issues raised by the comments are discussed below.

1. Number of Units to be Tested

Comments were received which raised two issues regarding the number of furnaces required to be tested.

First, an industry trade association outlined a procedure which would reduce the number of furnaces required to be tested for groups of furnaces utilizing forced air as the heating medium and which have heat exchangers consisting of a number of identical sections. The commenter felt the efficiency performance of furnaces of this design will be the same regardless of their size and therefore no need exists to test all basic models. The commenter concluded that the procedure outlined is statistically valid because differences in the various efficiency measures were insignificant even when a worse case analysis is performed. The commenter performed an "Analysis of Variance" on a manufacturer's line of forced air furnaces and concluded with 99 percent confidence that the efficiency variation seen within the line was due to chance variation and not due to any "true" or actual difference. The commenter concluded that, based on this "insignificant" difference, the efficiency measures of basic models in other related groups (for instance, basic models of the same heat exchanger design with electronic ignition added) can be predicted by the manufacturer, thus reducing his testing burden. DOE is of the opinion that this approach is a reasonable course of action to be taken by a manufacturer since no significant reduction in the probability of a manufacturer overstating his performance capability is likely to occur if every basic model of the line is tested in accordance with the existing sampling requirements.

DOE feels that the procedure outlined by the commenter is in accordance with the applicable DOE sampling provisions for representations and labeling, in particular the provision allowing components of similar design to be substituted without requiring additional testing and the provision allowing conservative rating of performance at the manufacturer's option. DOE feels the commenter's outlined procedure is an extension of these existing provisions and agrees that no changes to existing basic model definition or the sampling requirements are warranted at this time.

The above mentioned provisions (component substitution and conservative rating) have not been proposed as part of the standards program. Rather by notice issued June 19, 1980 (45 FR 43976 June 30, 1980), DOE has proposed that testing of all basic models be required in order to certify that the basic model meets or exceeds the standard.

DOE or FTC will not evaluate the statistical validity of a manufacturer's "analysis of variation" or other sampling plan when involved in any type of enforcement action under the Act, (i.e., representations, labeling or standards) whereas the commenter felt this should be the first area of investigation.

When DOE recognized component substitution and conservative rating in the sampling requirements for representations and labeling, it was not

[1] Subsequently, the Act was amended by the National Energy Conservation Policy Act (NECPA) (Pub. L. 95-619). References in this notice to "the Act" or to sections of the Act refer to the Energy Policy and Conservation Act as amended by NECPA.

outlining a less stringent enforcement technique to be used by DOE or FTC. All enforcement actions will be carried out on a model by model basis. The use of a reduced testing plan as proposed by the commenter is not a justifiable reason for reduced accuracy.

Second, manufacturers from the electric furnace industry and representatives of a trade association felt that a reduced testing requirement was warranted in regard to all electrical furnaces. The commenters correctly realized that the DOE test procedures assign an efficiency of 100 percent to all indoor installed electric furnaces; therefore no actual testing requirements exist for determining efficiency. However, for electrical furnaces installed in unheated spaces the test procedures require that the percent loss through the jacket be evaluated and deducted from 100 percent. This is consistent with what is done in the test procedures for fossil fuel furnaces installed in unheated spaces. The commenters believe this jacket loss test requirement is burdensome and can be eliminated by DOE assigning a constant percent jacket loss that can be used by all manufacturers and thereby eliminate the testing requirement when determining measures of efficiency for all electric furnaces. Some commenters also pointed out that DOE should not be pursuing this insignificant energy loss because a large number of electric furnaces are proximate to cooling coils and thus the casings, jackets or ducts are insulated to protect this cooling function. The commenters felt that for this reason the manufacturer would minimize jacket losses. However, DOE believes that no such incentive exist for electric furnaces built solely for heating. In any event, DOE believes that the manufacturer should be accountable for this energy loss whereas an assigned value removes this accountability entirely.

Furthermore, the conservative rating provisions discussed above in regard to fossil fueled furnaces also can be applied to electric furnaces to greatly reduce the testing requirements. For example, if a manufacturer determines the percent jacket loss of the model with the largest heating element and poorest jacket he could consider using this value in calculating efficiency of all his outdoor models as long as he is willing to certify that none of the untested models will perform at a lower efficiency.

For the measures of energy consumption other than efficiency, such as operating cost, electric furnace manufacturers may employ the same approach regarding testing requirements as allowed with the electrical furnace efficiency determinations.

2. Energy Factor

DOE has sought in the proposal to include in the test procedures a new efficiency measure which will reflect variations in the efficiency of electrical components of fossil fueled furnaces. Comments were received which express strong opposition to the use of the proposed energy factor (EF) as the measure of efficiency used in the energy efficiency standards program or the labeling program. The proposed EF takes into account the relative efficiency of furnace electrical components. Commenters felt that at this point in time the resulting confusion would outweigh any benefit that could be obtained by adopting the proposed EF as the measure of efficiency in lieu of the existing Annual Fuel Utilization Efficiency (AFUE).

DOE agrees with the commenters that adopting the proposed EF in lieu of the AFUE would be inappropriate and therefore is not contemplating changing the measure of efficiency used in the labeling or standards program. Much effort has been spent by Government and industry to help the public assimilate AFUE for the labeling program. Also much of the economic analysis that has been conducted in support of the energy efficiency standards program has been based on AFUE levels.

However, since the inclusion of this energy measure adds to the completeness of the test procedures (it will allow manufacturers to make representations regarding efficiency improvements attributable to high efficiency electrical components), DOE is prescribing this energy factor in today's final rule.

3. Condensing Furnaces

There was no major objection to the proposed test procedures for condensing furnaces and boilers, however there were some minor technical changes suggested which the commenters felt would serve to improve the test procedures.

Several comments suggested that the temperature specifications called out in the test procedures should be changed. One commenter stated that condensing furnaces should be tested at temperature rises below the specified 50°F if the unit is capable and designed to do so. However, DOE and National Bureau of Standards (NBS) feel the substantial improved performance resulting from such testing conditions would not be reflective of what would occur in actual use. NBS believes the maximum temperature rise specified by the manufacturer is likely to be the most representative temperature rise and thus should be specified instead of the present 50°F temperature rise. Therefore, DOE is prescribing that paragraph 2.5.1 be changed to require that the tests "be carried out at the maximum temperature rise specified by the manufacturer for the unit being tested."

In related comments it was requested that the more stringent temperature constraints specified for condensing furnaces and boilers should be adopted for non-condensing furnaces and boilers. Specifically, an industry trade association felt the proposed narrow limits of permissible return air temperatures should be adopted for non-condensing furnaces and a manufacturer of boilers felt all boilers should be tested at the same return water temperature and the tighter limits on return water temperature rise for condensing boiler should be adopted for noncondensing boilers. DOE and NBS do not agree with these suggested revisions. Non-condensing furnaces and boilers are not nearly as sensitive as condensing furnaces and boilers to return water/air temperatures. Stricter specifications for noncondensing furnaces and boilers could penalize some small manufacturers who do not have conditioned laboratories and DOE believes there exists no reason to increase the complexity of the test procedure for noncondensing furnaces or boilers when approximately the same results can be obtained using the presently specified conditions. Therefore, today's rule prescribes stricter testing conditions only for condensing furnaces and boilers.

This same boiler manufacturer failed to see the appropriateness of testing a condensing boiler at 120°F return water temperature and then correcting its efficiency to a return water temperature of 180°F in the calculations. DOE, however, feels this procedure is appropriate because only steady state efficiency, not the annual fuel utilization efficiency, is corrected to a return water tmeperature of 180°F. This is done because 180°F return water temperature is more typical of actual operation under full load, steady state conditions.

Also, there were comments received concerning the proposed equations for steady state efficiency of condensing furnaces and boilers. DOE agrees with the suggestion to include the terms latent heat loss coefficient "C_L" and condensate heat loss "L_C" in the equation for furnaces and to include brackets in the equation for condensing

boilers. DOE is correcting these oversights in today's rule.

Also, the equation for condensing boiler steady state efficiency was critized because inherent in this equation is the assumption that for each 1°F change in entering water temperature there is a 1°F change in flue gas temperature. NBS agrees that this assumption is not exact but it has an insignificant effect on the calculations of steady state efficiency and it avoids the need for an additional boiler test at a return water temperature of 180°F. Thus, DOE is not changing the provisions that were proposed.

Further, a manufacturer claimed the proposed provisions of requiring the return air temperature of a condensing furnace to be maintained within ±5°F of the value of the room temperature (T_{RA}) coupled with the existing provisions that T_{RA} may not fall below 65°F could allow for the testing of condensing furnaces at return air temperatures of 60°F. This temperature of return air would not be realistic of the temperature encountered in the field and testing at 60°F would result in undeserved performance improvement. NBS has determined that the performance improvement is small (about 0.15 percentage points). Nevertheless DOE is adding to section 2.5.1 the provision that the return air temperature shall not be below 65°F for condensing furnaces.

Further a manufacturer commented that the calculations should be expanded to allow condensing furnaces and boilers to have separate ratings depending on whether the furnace uses indoor or outdoor air for combustion. DOE disagrees because the use of oudoor air for rating all condensing furnaces and boilers is a justifiable simplification of an already difficult calculation procedure. And because of the low flue temperature of condensing units, this simplification has an insignificant effect on the annual fuel utilization efficiency. The calculations do not prevent condensing furnaces or boilers from using indoor air for combustion; they only, for purposes of simplicity, evaluate all condensing furnaces and boilers as if they were direct vent furnaces (using outdoor air).

Finally, some commenters questioned the assumption employed in the calculation that the flue gases for condensing furnaces and boilers are saturated. One commenter claimed that this dew point method of test could result in an error of 2 or 3 percentage points. However, in laboratory tests performed at NBS, a discrepancy of only 1 percentage point was observed between results obtained using the dew point temperature of the flue gases and those obtained by collecting and measuring condensate. NBS believes that the use of the flue gas dew point method is the better procedure due to the repeatability and ease with which the required measurements can be performed. Therefore, DOE is prescribing today the dew point method of test as proposed.

4. Commercial Standards

Today's notice incorporates as part of the test procedures the updated versions of the American National Standards Institute (ANSI) standards in lieu of the versions cited in the existing test procedures.

Pursuant to section 301 of the Department of Energy Organization Act (Pub. L. 95–91), DOE is required to comply with section 32 of the Federal Energy Administration Act of 1974 (FEA Act) (Pub. L. 93–275), as amended by section 9 of the Federal Energy Administration Authorization Act of 1977 (Pub. L. 95–70).

The findings required of DOE by section 32 of the FEA Act serve to alert the public and DOE to the use and background of commercial standards in a proposed rulemaking and, through the comment and hearing process, allow interested persons to make known their views regarding the appropriateness of the use of particular commercial standards in any proposed rulemaking.

All comments received concerning these standards expressed the approval of the updated ANSI standards. Also, DOE has consulted with the Attorney General and the Chairman of the Federal Trade Commission as required by section 32(c) of the FEA Act and neither recommends against such incorporation or use of the updated ANSI standards. Therefore, DOE is incorporating in today's final rule the ANSI Z21.47—1978 standard in lieu of ANSI Z21.47—1973.

5. Determination of Draft Factors

A manufacturer of a direct vent furnace requested that the option of performing the procedure specified in 3.6 of Appendix N for determining draft factors be allowed for non-power burner furnaces, whereas currently this procedure is limited to power burner systems. This commenter contends that direct vent furnace models exhibited draft characteristics which warrant a flue draft factor lower than that assigned in the test procedures ($D_F=1$).

The optional procedure was specifically designed to evaluate the draft characteristics of furnaces equipped with power burners, and at the time of the proposed rule DOE had determined whether the optional procedure would be applicable to non-power burner furnaces. Specifically, DOE expressed concerns, in the proposed rule, as to the accuracy and repeatability of the results obtained when using the tracer gas technique employed in the optional procedure.

In this regard NBS has been tasked with a project to conduct a complete analysis of this manufacturer's direct vent non-power burner furnace. The purpose of this analysis was to determine the actual draft factors representative of operation and, if necessary, to devise a uniform test method for the accurate determination of these draft factors. NBS has determined that a reduction in the "D_F" value exists for this design but was unable to develop a simplified uniform test method for the accurate determination of these draft factors. However, NBS found that results obtained when using the tracer gas technique were reasonably accurate and repeatable. For this reason, DOE is including in today's final rule the provisions to allow manufacturers the option of using the tracer gas procedure, outlined in section 3.6 of Appendix N, to determine the off-period draft factor for flue gas flow, D_F, when testing direct vent furnaces (with or without preheating of combustion air). Having this option on direct vent units will enable manufacturers of this type of furnace to account for the reduced off-period flow found in such systems.

6. Pulse Combustion

The proposed amendments to include condensing units was based on furnace designs which employ pulse combustion along with the condensing mode of operation. Pulse combustion designs include some type of valves that are likely to eliminate all flow through the furnace during the off-period. Because of this and because it was thought that all pulse combustion furnace designs would include the condensing mode, NBS recommended, and DOE adopted, a procedure that would permit, at manufacturers' option, testing only under steady state conditions as specified in section 3.7 of Appendix N. However, commenters pointed out that some designs of pulse combustion units may not include the condensing mode and also other designs, not just pulse combustion, could have no flow conditions during the off-period. Therefore, today's final rule prescribes that the term pulse combustion be replaced by the expression "any unit whose design is such that not air flows through the combustion chamber and heat exchanger during the off-period." Also the option in section 3.7 is

extended to only condensing units with no off-period losses. Thus, the option in 3.7 is not extended to noncondensing furnaces because a noncondensing furnace has high flue gas temperatures which have a substantial effect on seasonal efficiency.

7. Finned Tube Boilers

One commenter believed the arguments presented in the proposal relative to water flow rate for finned tube boilers apply equally to any low water volume boiler. Accordingly, the commenter felt the proposed revisions to 2.5.4 should be applicable to all low water volume boilers and DOE should define "low water volume" rather than "finned tube." DOE sees no advantage in attempting to define "low water volume" since to the best of NBS's knowledge only finned tube boilers have the problem of boiling at high water temperature rises. Until such a problem in found to exist on other designs, DOE will prescribe the provision for finned tube boiler water flow rates as proposed.

The proposed rule also allowed the capacity (Q_{out}) of finned tube boilers be calculated without regard to the adjustment which accounts for the difference in jacket heat losses measured at laboratory conditions and jacket heat losses that would occur at outside design conditions. Commenters suggested that other designs could deserve the same treatment. However, DOE feels it is inappropriate to give general applicability ruling and therefore, today's rule reflects only the changes resulting from the applications for exceptions filed by the manufacturers of finned tube boilers.

A related comment stated that the treatment of finned tube boilers was inconsistent in that the jacket heat loss adjustment factor is unity in the calculations for capacity but the factor C_j, which also is a jacket loss adjustment factor remains the same for all boilers in the calculations for AFUE. This commenter failed to realize that there is no direct relationship between the values assigned to C_j in the AFUE calculations and the coefficients appearing in front of L_j in the Q_{out} calculations. As mentioned above, the laboratory measured jacket loss (L_j) is adjusted for outside design conditions when calculating capacity. This is done because an outside furnace or boiler is likely to see outdoor design conditions at full capacity, whereas, the C_j factor in the calculations for AFUE adjusts the laboratory measured jacket loss for the effects of cycling and average outside conditions. A misinterpretation exists because the numerical value of these two adjustments is identical for forced air furnaces. DOE is currently considering expanding the list of adjustment factors, C_j, for all designs and installations but this requires considerable research. This research is not complete at this point in time. DOE and NBS are analyzing the entire jacket heat loss question. Once this research is completed, comprehensive assignment of jacket heat loss factors depending not only on design but also installation may be possible.

8. Room Temperature Measurement

Three comments were received regarding the procedures used to determine the test measure of room temperature, T_{RA}. First, it was suggested that the room temperature be measured with only one thermocouple instead of the specified four thermocouples because the commenter felt one is sufficient and there are no instructions regarding which (of the four) temperature readings should be used in the calculation procedure. However, DOE believes the four thermocouples provide a necessary level of accuracy and reliability of room temperature measurement, and the proposed section 2.9 clearly states that the four readings are to be averaged to find the value of T_{RA}, which is to be used in the calculation procedure.

This same commenter felt that other types of thermocouples besides the specified "iron-constantan" thermocouple should be allowed. NBS and DOE agree with the commenter and the words "iron-constantan" are deleted from section 2.9 in today's rule.

Finally, a manufacturer of a direct vent type of furnace believed it would be appropriate to raise the specified plane of measurement of T_{RA} so that the value obtained would be more reflective of the actual combustion air inlet temperature. This particular design has its inlet air and exhaust air openings located proximate to one another at the top of the furnace. The proposed amendments specify that the room air temperature and inlet air temperature should agree within ±5° F. DOE believes this provision is well within the ability of the manufacturer and provides equitable testing conditions. However, the commenter felt a superior solution of the problem would be for DOE to allow measurement of T_{RA} at the plane of air inlet. NBS has analyzed this problem and has concluded that the perceived temperature difference is not only due to some stratification of the air temperature in the testing laboratory but is primarily due to recirculation of hot flue gases into the cumbustion air intake. DOE feels that both these effects are artificial and should be avoided when testing. Therefore no change in the location where T_{RA} is measured is prescribed in today's rule.

9. Definition of Furnace

DOE has proposed to amend the definition of furnace in section 430.2 in order to more clearly define the applicability of the furnace test procedures by including the words "utilizing single phase electric current." Several commenters concurred with this change stating that it would have the desired effect of excluding from coverage some basic models using three-phase electric current that would otherwise be covered by the test procedures, but which are intended primarily for commercial applications. However, one commenter pointed out that the inclusion of the term "single-phase electric current" could be interpreted as excluding gas-fired units utilizing self energizing controls since DC millivoltage circuits are not usually considered "single-phase electric current." DOE agrees and is adding to the definition of furnace the words "or millivoltage DC current" in today's rule.

10. Draft Requirements

In order to better reflect field conditions in the laboratory, section 3.2.2 of the test procedures specifies that the draft in the flue must be maintained during the cool down test of oil fired boilers. This is done because the thermal mass of the venting system in the field will typically impose a draft on the furnace during this off-period. A commenter contended that this draft requirement should be deleted to simplify the running of the test because this requirement does not significantly affect the test results. NBS and DOE believe that this statement is correct for units equipped with power burners that have small off-cycle air flows but probably not correct for all types of oil fired units and therefore believe this requirement should not be relaxed at this time. However, DOE might consider a future research program to determine whether this requirement could be relaxed for certain types of oil fired equipment.

11. Conflicting Testing Conditions

The furnace test procedures currently specify restrictions on voltage, external static pressure, and temperature rise across the heat exchanger. Comments noted that on a few basic models these restrictions could conflict with one another. For example, at the specified static pressure and temperature rise, outlined in section 2.5.1, a particular furnace may not be able to meet the

requirement that the testing voltage be within one percent of nameplate as specified in section 2.3.5. DOE agrees and is correcting this problem in today's rule by expanding section 2.5.1 to outline the priorities of these restrictions.

12. Nameplate Input Ratings

DOE has proposed to use the nameplate input rating in lieu of the measured input to prevent variations in the derived capacity. The proposed rule reflected this by changing the calculations for capacity in section 4.7. A commenter noted that the intent of this amendment will not be served until this change is also carried out in sections 4.2.34, 4.2.35, 4.8, and 4.12. NBS and DOE agree and is prescribing in today's rule that the measured input term Q_{in} in the above sections should be replaced by a new variable, Q_{np}, which would stand for the nameplate input rating.

13. Insulation on Flue Pipe During Testing

As discussed in Item 7 of the proposed rule, DOE intended to include provisions that would require insulation of exposed areas of flue pipe. A commenter stated, however, that the language in the proposed section 2.2.1.2 does not accomplish this intent. DOE agrees and is changing the appropriate sentences in this paragraph to read: "Test gas-fueled furnaces having a horizontally discharging hood outlet with the draft hood in place and elbow and a 5 foot long vertical pipe attached to the hood outlet. Insulate the flue pipe upstream of the draft hood."

14. Propane Gas Testing

One commenter suggested that since the American National Standards Institute (ANSI) Z21.47 1978 recognizes other liquid petroleum gases (LPG) besides propane, DOE should allow testing with other LPG's. NBS and DOE do not feel this expansion of procedures is warranted because results obtained using readily available propane are adequate to describe the performance of LPG burning furnaces regardless of the type of LPG.

This same commenter also suggested that manufacturers of furnaces fueled by either natural gas or propane be allowed to rate all models based on only natural gas testing. In accordance with the currently prescribed provisions of conservative rating discussed above in Item 1, this testing and rating method is allowed as long as the tested models' ratings are known to be below the ratings of the untested models.

15. CO_2 Readings

One of the proposed amendments allowed for measuring the CO_2 concentration at a location downstream of the plane of temperature measurement. This amendment served to eliminate problems regarding nonrepeatable test data, without compromising the reliability of measures of energy consumption derived from the test procedures. A commenter has brought to DOE's attention an instance in the test procedure where this provision was omitted. Therefore, DOE is today adding the words "or within 3.5 feet of this plane on the downstream side" to paragraph 7 of proposed section 3.1.1.

16. Temperature Measurement Times

One commenter felt that an explanation is needed to justify why the times at which the temperature measurements are taken differ for condensing and non-condensing furnaces. The only time that is changed for condensing furnaces is the time at which the flue gas temperature "$T_{t.off(\infty)}$" is measured. This has been reduced to 20 minutes after burner shut down for condensing boilers without pilot lights. This reduction in testing time is warranted since condensing boilers start the cool down process from a lower temperature than noncondensing boilers would and therefore equilibrium is reached sooner.

17. Blower Delay Time

One commenter requested that the test procedures should be modified to allow furnaces with a timing device for blower shutdown to be tested with the timer operating in its normal manner, whereas, the test procedures currently require blower shutdown at 3 minutes after burner shutdown or when the supply air temperature drops to a value of 40°F above the inlet air temperature, whichever results in the longest blower on time. DOE feels these existing provisions should remain because: (a) There is a desire to provide a fixed set of test conditions, representative of field conditions, that would facilitate the performance comparison of different furnaces, (b) there is a desire to discourage manufacturers from sacrificing the comfort of the homeowner for the sake of minute improvement in the efficiency number assigned to a furnace, (NBS believes supplying air at a temperature which is less than 40°F above inlet air temperature could be uncomfortable to the homeowner), and (c) there is a desire to prevent manufacturers from improving through increased use of electricity, their AFUE level at the expense of the annual operating cost. The latter follows from the fact that AFUE does not include the electrical energy consumption on gas or oil-fueled furnaces, but is included in the calculation procedures for determining the annual operation cost.

This same commenter requested that the test standard be modified to give proper credit to units that are designed such that the indoor blower starts simultaneously with the burner, whereas the test procedures specify a time delay (t#) between the burner startup and blower startup of 1.5 minutes for this type of design. DOE is also not changing this provision because the time delay (t#) of 1.5 minutes between blower and burner startup was fixed in the furnace test procedure for the same reasons cited above for the 3 minute delay between burner and blower shutdown. As in the above case, the 1.5 minute delay was chosen to be typical of most furnaces operating in the field and to minimize the total (fuel + electric) annual operating cost.

18. Miscellaneous

After careful consideration of all of the comments and further consultation with NBS, DOE has made some editorial and minor technical changes (for instance, added brackets, where appropriate, to the equations in section 4.2.5) in the prescribed amendments to the test procedures that were not discussed above and incorporated them in the final rule prescribed today.

C. Regulations Prescribed

1. *Test Procedures.* The amendments to the test procedures for furnaces prescribed today are included in Subpart B of Part 430 and are substantially the same as those proposed, with the exception of the changes discussed above. Specifically, in discussion comment number 4 above, today's final rule incorporates as part of the test procedures the updated versions of the American National Standards Institute (ANSI) standards in lieu of the versions cited in the existing test procedures. Any subsequent amendment to these standards by the standard-setting organizations will not affect the DOE test procedures, which can only be amended by DOE.

2. *General Provisions.* Today's rulemaking contains an amended definition of "Furnace."

3. *Application of Test Procedures.* For the convenience of the reader, today's amendments contain the previously prescribed statistical sampling provisions for any testing required in order to comply with sections 323(c) and

324 of the Act. Section 323(c) provides that, effective 180 days after a test procedure rule applicable to a covered product is prescribed by DOE, no manufacturer, distributor, retailer, or private labeler may make any representation in writing or in any broadcast advertisement respecting the energy consumption or cost of energy consumed by that covered product, unless the product has been tested in accordance with the DOE test procedure, and the representation fairly discloses test results. Section 333(c) of the Act assigns enforcement responsibility for this provision to the Federal Trade Commission (FTC). The test procedures prescribed today are also applicable to any labeling rules which may be prescribed by the FTC pursuant to section 324 of the Act.

The test procedure provisions prescribed today, other than the sampling provisions of § 430.23(m), are expected to be used generally for determining compliance with future standards, but the exact method of determining compliance will be decided upon during the ongoing efficiency standards setting process. The sampling provisions of § 430.23 are specifically intended to apply only to testing required pursuant to sections 323(c) and 324 of the Act. Future DOE regulations relating to the selection of units, for testing to ensure compliance with efficiency standards under section 325, may differ substantially from the approach taken in the sampling provisions of § 430.23.

4. *Unit Costs of Energy.* Under section 323(b)(2) of the Act, DOE is required to provide manufacturers with information on representative average unit costs of energy. This information was provided by notice issued June 22, 1979 (44 FR 37534, June 27, 1979), and is expected to be updated in the near future.

5. *Preemption.* Today's rulemaking prescribing final amended test procedures for furnaces supersedes any State regulation to the extent required by section 327 of the Act. Pursuant to section 327, all State regulations which provide for the disclosure of information with respect to any measure of energy consumption of furnaces or which provide for an energy efficient standard, or other requirement regarding the energy efficiency or energy use of furnaces, must now employ test procedures identical to those specified in today's final rule.

6. *Regulatory and Environmental Review.* In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), DOE evaluated the proposed establishment of these test procedures for consumer products to determine if an environmental assessment or an environmental impact statement was required. These test procedures will be used only to standardize the measurement of energy usage for the subject consumer products. The action of prescribing the test procedures, by itself, will not result in any environmental impact. Because it was clear that the proposed action was not a major Federal action significantly affecting the quality of the human environment, DOE determined that neither an environmental assessment nor an environmental impact statement was required. The potential environmental impacts that might occur from the application of the test procedures in connection with DOE's energy efficiency standards program will be evaluated by the program.

This rule has been reviewed in accordance with Executive Order 12044 and DOE Order 2030.1. It was determined that this rule was significant in nature but did not have major impacts to manufacturers and consumers imposing annual economic costs of $100 million or more.

In consideration of the foregoing, Part 430 of Chapter II of Title 10, Code of Federal Regulations, is amended as set forth below, effective September 11, 1980.

Issued in Washington, D.C., August 4, 1980.

T. E. Stelson,

Assistant Secretary, Conservation and Solar Energy.

1. Section 430.2 is amended by revising the definition of "furnace" to read as follows:

§ 430.2 Definitions.

* * * * *

"Furnace" means a device, utilizing only single-phase electric current, or single-phase electric current or millivoltage DC. current in conjunction with either natural gas, propane, or home heating oil, which is designed to be the principal heating source for the living space of a residence and which is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu's per hour. Every furnace is either an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler. The heat input rate of a furnace is less than 300,000 Btu's per hour for electric boilers and low pressure steam or hot water boilers, and is less than 225,000 Btu's per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

* * * * *

2. Section 430.22 is amended by redesignating the present paragraph (n)(4) as paragraph (n)(5) and by adding a new paragraph (n)(4) to read as follows:

§ 430.22 Test procedures for measures of energy consumption.

* * * * *

(n) *Furnaces.* * * *

(4) The energy factor for fossil-fueled furnaces, expressed in percent, is the ratio of annual output of useful energy delivered to the heated space to the total annual energy input to the furnace determined according to 4.15 of Appendix N of this subpart.

* * * * *

3. The provisions of § 430.23 which relate to furnaces are reprinted as follows for the convenience of the reader:

§ 430.23 Units to be tested.

When testing of a covered product is required to comply with section 323(c) of the Act or to comply with rules prescribed under section 324 of the Act, a sample shall be selected and comprised of units which are production units, or are representative of production units of the basic model being tested, and shall meet the following applicable criteria.

* * * * *

(n)(1) For each basic model[2] of furnaces, other than basic models of those sectional cast-iron boilers which may be aggregated into groups having identical intermediate sections and combustion chambers, a sample of sufficient size shall be tested to insure that—

(i) Any represented value of estimated annual operating cost, energy consumption or other measure of energy consumption of a basic model for which consumers would favor lower values shall be no less than the higher of (A) the mean of the sample, or (B) the upper 97½ percent confidence limit of the true mean divided by 1.05, and

(ii) Any represented value of the annual fuel utilization efficiency or other measure of energy consumption of a basic model for which consumers would favor higher values shall be no greater than the lower of (A) the mean of the sample, or (B) the lower 97½ percent confidence limit of the true mean divided by .95.

(2) For the lowest capacity basic model[2] of a group of basic models of those sectional cast-iron boilers having identical intermediate sections and combustion chambers, a sample of sufficient size shall be tested to insure that—

(i) Any represented value of estimated annual operating cost, energy consumption or other measure of energy consumption of a basic model for which consumers would favor lower values shall be no less than the higher of (A) the mean of the sample, or (B) the upper 97½ percent confidence limit of the true mean divided by 1.05, and

(ii) Any represented value of the fuel utilization efficiency or other measure of energy consumption of a basic model for which consumers would favor higher values shall be no greater than the lower of (A) the mean of the sample, or (B) the lower 97½ percent confidence limit of the true mean divided by .95.

(3) For the highest capacity basic model[2] of a group of basic models of those sectional cast-iron boilers having identical intermediate sections and combustion chambers, a sample of sufficient size shall be tested to insure that—

(i) any represented value of estimated annual operating cost, energy consumption or other measure of energy consumption of a basic model for which consumers would favor lower values be no less than the higher of (A) the mean of the sample, or (B) the upper 97½ percent confidence limit of the true mean divided by 1.05, and

(ii) Any represented value of the fuel utilization efficiency or other measure of energy consumption of a basic model for which consumers would favor higher values shall be no greater than the lower of (A) the mean of the sample, or (B) the lower 97½ percent confidence limit of the true mean divided by .05.

(4) For basic model[2] or capacity other than the highest or lowest of the group of basic models [2] of sectional cast-iron boilers having identical intermediate sections and combustion chambers, represented values of measures of energy consumption shall be determined by either—

(i) A linear interpolation of data obtained for the smallest and largest capacity units of the family, or

(ii) Testing a sample of sufficient size to insure that (A) any represented value of estimated annual operating cost, energy consumption or other measure of energy consumption of a basic model for which consumers would favor lower values shall be no less than the higher of (1) the mean of the sample, or (2) the upper 97½ percent confidence limit of the true mean divided by 1.05, and (B) any represented value of the energy factor or other measure of energy consumption of a basic model for which consumers would favor higher values shall be no greater than the lower of (1) the mean of the sample, or (2) the lower 97½ percent confidence limit of the true mean divided by .95.

(5) Whenever measures of energy consumption determined by linear interpolation do not agree with measures of energy consumption determined by actual testing, the values determined by testing will be assumed to be the more reliable values.

(6) In calculating the measures of energy consumption for each unit tested, use the design heating requirement corresponding to the mean of the capacities of the units of the sample.

4. Section 1.18 of Appendix N to Subpart B is amended to read as follows:

1.18 "Steady state heat input" (Q_{in}) means the rate of energy supplied in a fuel to a furnace, operating under steady state conditions, expressed in Btu's per hour. It includes any input energy to the pilot light and is obtained by multiplying the measured rate of fuel consumption by the measured higher heating value of the fuel.

5. Section 1.27 of Appendix N to Subpart B is amended to read as follows:

1.27 "Heating capacity" (Q_{out}) means the rate of useful heat output from a furnace, operating under steady state conditions, expressed in Btu's per hour. For furnaces intended to be installed indoors, it is obtained by multiplying the "nameplate input" by the steady state efficiency (n_{ss}) divided by 100. For furnaces intended to be installed outdoors, it is obtained by multiplying (A) the "nameplate input" by (B) the difference of the steady state efficiency divided by 100 and the quantity (3.3) (L_j) divided 100, where L_j is the jacket loss as determined in 3.4 of this appendix. For finned tubed boilers intended to be installed outdoors, it is obtained by multiplying (A) the "nameplate input rating" by (B) the difference of the steady state efficiency divided by 100 and the quantity L_j divided by 100, where L_j is the jacket loss as determined in 3.4 of this appendix.

6. Appendix N to Subpart B is amended by adding, after § 1.27, the following new sections:

1.28 "Condensing furnace" means a furnace or boiler which condenses part of the water vapor generated by the burning of hydrogen in fuels and is equipped with a means of collecting and draining this condensate. A furnace or boiler shall be considered a "condensing furnace" only if the latent heat loss coefficient (C_L), defined in 1.29 below, is less than 1.

1.29 "Latent heat loss coefficient (C_L)" means the coefficient which is the fraction of the total latent heat remaining in the flue gases after any condensing has occurred, as calculated in section 4.17 of this appendix.

1.30 "Pulse combustion furnace" means a furnace or boiler which uses a steady sequence of explosions to produce heat.

1.31 "Nameplate input rating" (Q_{in}) means the maximum hourly Btu input rate affixed by the manufacturer to a fossil-fueled furnace to indicate the fuel burning capacity.

1.32 "Finned tube boiler" means a boiler whose heat exchanger consists of only finned tubes.

1.33 "Forced draft" means air forced into the combustion chamber by mechanical means.

1.34 "Direct exhaust system" means a furnace venting system supplied by the manufacturer through which the products of combustion pass directly from the furnace to the outside and which does not employ a means of draft relief.

7. Section 2.1 of Appendix N to Subpart B is amended to read as follows:

2.1 *Installation of test plenum, duct work, and piping.*

2.1.1 Gravity central furnaces (including direct vent systems). Install and equip gravity central furnaces with a vertical supply test plenum or extended casing and horizontal test ducts as described in section 2.3.3 of ANSI Standard Z21.47–1978.

2.1.2 Forced-air central furnaces (including direct vent systems). Equip gas-fueled forced-air central furnaces with a plenum and test duct as described in Sections 2.3.1 and 2.3.2 of ANSI Standard Z21.47–1978. Equip oil-fueled forced-air central furnaces with a plenum and test duct as described in Section 6.2 of ANSI Standard Z91.1–1972.

2.1.3 Low pressure steam and hot water boilers (including direct vent systems). Install gas-fueled low pressure steam and hot water boilers as prescribed in section 2.9 of ANSI Standard Z21.13–1974. Install oil-fueled low pressure steam and hot water boilers as prescribed in sections 7.0 and 8.1.1 through 8.1.3 in the January 1977 edition of the Hydronic Institute "Testing and Rating Standard for Cast Iron and Steel Heating Boilers." In the case of condensing boilers, a means shall be provided for supplying 120° F return water, at a constant rate, to the test boiler during both the steady state and heat-up tests described below. This will typically, although not necessarily, require the use of a large tank, an auxiliary boiler and two pumps.

2.1.4 Electric central furnaces. Install equipment for testing in accordance with ARI Standard 230–74, section 4 and figure 1.

2.1.5 Electric boilers.

Install equipment in accordance with manufacturer's instructions.

8. Section 2.2.1.2 of Appendix N to Subpart B is amended to read as follows:

2.2.1.2 Gas-fueled gravity and forced-air central furnaces which employ draft hoods.

[2] Components of similar design may be substituted without requiring additional testing if the represented measures of energy consumption continue to satisfy the applicable sampling provision.

Test gas-fueled gravity and forced-air central furnaces which employ draft hoods having vertically discharging outlets with the draft hood in place and a 5-foot long pipe attached to the hood outlet. Test gas-fueled furnaces having a horizontally discharging hood outlet, with the draft hood in place and an insulated elbow and 5-foot long vertical pipe attached to the hood outlet. Insulate the flue pipe upstream of the draft hood with insulation having an R value not less than 7 (°F–HR-ft²/Btu's) and an outer layer of aluminum foil. Use an elbow and pipe with a cross sectional area the same size as the hood discharge outlet.

9. The first sentence of section 2.2.3 of Appendix N to Subpart B is amended to read as follows:

2.2.3 Direct vent and direct exhaust systems.

9a. Section 2.3.3 of Appendix N to Subpart B is amended to read as follows:

2.3.3 Other test gas. The specific gravity of other test gases shall approximate the values given in Table VII of ANSI Standard Z21.47–1978. Maintain the test pressures immediately ahead of all controls between the "normal" and "increased" values of test pressures given in Table VIII in the ANSI Standard. Use gas with a measured higher heating value within ±5 percent of the values specified in Table VII of ANSI Standard Z21.47–1978. Determine the actual higher heating value of the gas used in the test with an error no greater than 1 percent.

10. Section 2.4.1 of Appendix N to Subpart B is amended to read as follows:

2.4.1 Gas burner adjustments (not including condensing furnaces). Adjust burners of gas-fueled furnaces or boilers such that the Btu's per hour input, as measured during the steady state performance test described below and corrected to standard conditions of 80° F and 30 inches of mercury barometric pressure, is within ±2 percent of the nameplate input rating. Set the primary air shutters in accordance with the manufacturer's recommendation to give a good flame at this adjustment. If, however, the setting results in the deposit of carbon during any test specified herein, the tester shall adjust the shutters and burners until no more carbon is deposited and shall perform the tests again with the new settings. After the steady state performance test has been started, do not make additional adjustments to the burners during the required series of performance tests specified in section 3.0 of this appendix.

If a vent limiting means is provided on a gas pressure regulator, keep it in place during all tests.

11. Section 2.4.2 of Appendix N of Subpart B is amended to read as follows:

2.4.2 Oil burner adjustments (not including condensing furnaces). Adjust the burners of oil-fueled furnaces or boilers to give the CO_2 reading recommended by the manufacturer and an hourly Btu input during the steady state performance test described below which is within ±2 percent of the furnace nameplate input rating. Smoke in the flue may not exceed a No. 1 smoke during the steady state performance test as measured by the procedure in ANSI Standard Z11.182–1965 (R1971) (American Society for Testing and Materials D 2158–65 (1970)). Maintain the average draft over the fire and in the flue during the steady state performance test at that recommended by the manufacturer. Do not allow draft fluctuations exceeding 0.005 inches of water gauge. Do not make additional adjustments to the burner during the required series of performance tests. The instruments and measuring apparatus for this test are described in section 6.3 of ANSI Standard Z991.1–1972.

12. Appendix N to Subpart B is amended by adding, after section 2.4.2, the following new section:

2.4.3 Gas and oil burner adjustments for condensing furnaces. The burners on gas- and oil-fueled condensing furnaces and boilers shall be adjusted to give, during the steady state performance test described below, the CO_2 reading recommended by the manufacturer (if applicable) and an hourly Btu input which is within ±2 percent of the nameplate input rating. During the steady state performance test, the concentration of carbon monoxide present in dry flue gas shall not exceed 0.04 percent by volume. For oil-fired condensing units, the smoke in the flue gases shall not exceed a No. 1 smoke during the steady state performance test as measured by the procedure in ANSI Standard Z11.182–1965 (R 1971) (ASTM D2156–65 (1970)). If the carbon monoxide or smoke exceeds these specified limits during the steady state test, the burner shall be readjusted to give a lower CO_2 reading and all tests shall be started over. Once the burner is properly adjusted, no additional adjustments shall be made to it during the required series of performance tests.

If a vent-limiting means is provided on a gas pressure regulator, it shall be in placed during all tests.

13. Section 2.5.1 of Appendix N to Subpart B is amended to read as follows:

2.5.1 Gas-fueled forced-air central furnaces (including direct vent systems and condensing furnaces).

Adjust the external static pressure and air flow rate as specified in section 2.6 of ANSI Standard Z21.47–1978 and measure the inlet and outlet air temperatures in accordance with section 2.3.2 of this ANSI standard. If the above requirements on temperature rise and static pressure cannot simultaneously be met and the temperature rise does not exceed the maximum temperature rise specified by the manufacturer when the unit is operated against the minimum external static pressure specified in section 2.6 of ANSI Standard Z21.47–1978, then the blower motor voltage shall not be increased and the temperature rise shall be the lowest value attainable at the required minimum external static pressure, provided that it is not less than 15° F (8.5° C) below the manufacture's recommended maximum temperature rise. If the above restriction on not exceeding the maximum temperature rise specified by the manufacturer cannot be met while maintaining the required minimum external static pressure, then the voltage to the blower motor shall be increased to obtain the maximum temperature rise specified by the manufacturer at the required minimum external static pressure.

For gas-fueled condensing furnaces, the temperature rise during the steady state test described below shall be the maximum temperature rise specified by the manufacturer with the unit operating against a static pressure equal to a greater than the minimum external static pressure specified in section 2.6 of ANSI Standard Z21.47–1978. The static pressure shall be adjusted by symmetrically restricting the outlet air duct. If the above requirements on temperature rise and static pressure cannot simultaneously be met, then the blower motor voltage shall be increased. During the steady state and heat-up tests described below, the return air temperature to the condensing furnace shall remain within ±5° F of the value T_{RA} measured during the steady state performance tests and shall not be below 65° F.

If the above procedures require the voltage to the blower motor to be changed, then the requirements of section 2.5.3, relating to the blower motor voltage, are waived.

13a. Section 2.5.2 of Appendix N to Subpart B is amended to read as follows:

2.5.2 Gravity central furnaces (including direct vent systems). Maintain the air flow rate through the furnace such that the average normal air temperature rise at steady-state is not greater than 130° F above the inlet air temperature when the furnace is equipped with the vertical test plenum of extended casing and horizontal test ducts as described in section 2.1.1. Measure the outlet air temperature as specified in section 2.3.3 of ANSI Standard Z21.47–1978. Measure the inlet air temperature measured at the center of the plane of each inlet air opening by means of a single No. 24 American Wire Gauge (AWG) thermocouple, suitably shielded from direct radiation.

14. Section 2.5.3 of Appendix N to Subpart B is amended to read as follows:

2.5.3 Oil-fueled forced-air central furnaces (including direct vent systems and condensing furnaces). Adjust the external static pressure and air flow rate as specified in table 5 and section 6.2 of ANSI Standard Z91.1–1972. For oil fueled condensing furnaces, the temperature rise during the steady state tests described below shall be the maximum temperature rise specified by the manufacturer. During the steady state and heat-up tests described below, the return air temperature to the condensing furnace shall remain within ±5°F of the value T_{RA} measured during the steady state performance test.

15. Section 2.5.4 of Appendix N to Subpart B is amended to read as follows:

2.5.4 Gas- and oil-fueled low pressure steam and hot water boilers (including direct vent systems and condensing boilers). For hot water boilers, adjust the water flow rate to produce a water temperature rise during steady state operation of between 120°F (48.9°C) and 185°F (73.9°C) and an outlet water temperature of 200°F (93.3°C) ±5°F (2.8°C). For finned tube boilers, the water flow shall be adjusted to produce a temperature rise of 20 to 40°F and outlet water temperature of 200°F ±5°F. Also for finned tube boilers, the maximum permissible temperature variation of the return water is limited to 5°F. For steam boilers, conduct the steady state performance test described in 3.1 at atmospheric pressure or at a pressure not exceeding 2 psia.

For condensing hot water boilers, the water flow rate shall be adjusted to produce a water temperature rise, during the steady state test described below, which is between 19.5 and 20.5°F. During the steady state and heat-up tests, the condensing boiler shall be supplied with return water having a temperature of 120°F. The maximum permissible variation of the return water temperature from the required value during the steady state and heat-up tests shall not exceed ±2°F, except during the first 30 seconds after start-up when it shall not exceed ±10°F, and between 30 and 60 seconds after start-up it shall not exceed ±5°F.

16. Section 2.6.1 of Appendix N to Subpart B is amended to read as follows:

2.6.1 Gas-fueled gravity furnaces, forced-air furnaces, and boilers (including direct vent systems and condensing furnaces and boilers). For units employing an integral draft diverter, install a grid of thermocouples wired in parallel, in a horizontal plane in the 5-foot test stack located 1 foot from the test stack inlet. The grid shall consist of either 9 or 17 thermocouples (manufacturer's option) if the nominal inside diameter of the flue pipe is greater than 2 inches and 5 thermocouples if the nominal inside diameter of the flue pipe is less than or equal to 2 inches. Henceforth in this section all parenthetical expressions refer to the 17 thermocouple grid, and all bracketed expressions refer to the 5 thermocouple grid. Equalize the length of all thermocouple leads before paralleling. Arrange the thermocouples in a grid with 1 thermocouple in the center of the test stack, and 8 (16) [4] along imaginary lines intersecting at right (45 degree) [right] angles in the horizontal plane at points one-third and two-thirds (one-third and two-thirds) [half] of the distance between the center of the pipe and the pipe wall.

For units which employ a draft hood, or a direct vent system which does not significantly preheat the incoming combustion air, install the thermocouple grid described above in a horizontal plane located within 12 inches (304.8 mm) of the furnace or boiler outlet, and upstream of the draft hood on units so equipped. Equalize the length of all thermocouple leads before paralleling and arrange the thermocouples as described above.

For furnaces or boilers which employ direct vent systems that significantly preheat the incoming combustion air, install the thermocouple grid described above in a plane parallel to and located within 6 inches (152.4 mm) of the vent/air intake terminal. Equalize the length of all thermocouple leads before paralleling and arrange the thermocouples as described above.

Use bead-type thermocouples having wire size not greater than No. 24 AWG. If there is a possibility that the thermocouples could receive direct radiation from the flame, install radiation shields on the flame side of the thermocouples only and position the shields so that they do not touch the thermocouple junctions.

Locate the thermocouples used for measuring conditioned warm air as described in ANSI Z21.47–1978, sections 2.3.1, 2.3.2, and 2.3.3. Measure the temperature of the inlet air by means of a single No. 24 AWG bead-type thermocouple, suitably shielded from direct radiation and located in the center of the plane of each inlet air opening.

For non-condensing boilers, measure the inlet and outlet water temperature on gas-fueled hot water boilers as shown in figure 3 of ANSI Standard Z21.13–1974. For condensing boilers, the inlet and outlet water temperatures shall be measured using sheathed thermocouples inserted through pipe plugs that are located within 12 inches of the inlet and outlet of the boiler. A minimum of 6 inches of thermocouple lead, immediately upstream of the thermocouple junction, shall be immersed in the water between the pipe plug and the boiler inlet/outlet. The remainder of the thermocouple lead shall be run along the surface of the pipe (and under any insulation) for a distance of not less than 3 feet. The pipe, 3 feet immediately before the boiler inlet and 3 feet immediately after the boiler outlet, shall be covered with insulation having a R value of not less than 7 (°F-h-ft²/Btu) and an outer layer of aluminum foil.

17. Section 2.6.2 of Appendix N to Subpart B is amended to read as follows:

2.6.2 Oil-fueled forced-air central furnaces and boilers (including direct vent systems and condensing furnaces and boilers). Install a grid of thermo-couples, wired in parallel and having equal length leads, in a plane perpendicular to the axis of the flue pipe. For systems other than direct vent systems which significantly preheat the incoming air, locate this plane at the position of the single thermocouple shown in figure 2 of ANSI Standard Z91.1–1972. For direct vent systems which significantly preheat the incoming air, locate the plane within 6 inches (152.4 mm) of the outlet of the vent/air intake terminal. Arrange the thermocouples as described in section 2.6.1.

Use bead-type thermocouples having a wire size not greater than No. 24 AWG. If there is a possibility that the thermocouples could receive direct radiation from the flame, install radiation shields on the flame side of the thermocouples only and position the shields so that they do not touch the thermocouple junctions.

Locate the thermocouples for measuring conditioned warm air as described in section 6.2 of ANSI Standard Z91.1–1972. Measure the temperature of the inlet air by means of a single thermocouple, suitably shielded from direct radiation and located in the center of the plane of each inlet air opening.

For non-condensing boilers, measure the inlet and outlet water temperatures on oil-fueled hot water boilers as described in section 7.4 and figure 2 of the January 1977 edition of the Hydronic Institute Standard "Testing and Rating Standard for Cast Iron and Steel Heating Boilers." For condensing oil-fueled boilers, the inlet and outlet water temperature shall be measured as described in 2.6.1 for gas-fueled condensing boilers.

18. Section 2.7 of Appendix N to Subpart B is amended to read as follows:

2.7 *Combustion measurement instrumentation.* Analyze the samples of stack and flue gases for furnaces and determine the concentration by volume of CO_2 present in the dry stack or flue gas with instrumentation which will result in a determination of the CO_2 concentration with an error no larger than ±0.1 percentage points.

19. Section 2.9 of Appendix N to Subpart B is amended to read as follows:

2.9 *Room ambient temperature.* During the time period required to perform all the testing and measurement procedures specified in section 3.0, maintain the room temperature within ±5°F (+2.8 C) of the value T_{RA} measured at the end of the steady state performance test. During these tests, the room temperature may not exceed 100°F (37.8 C) or fall below 65°F (18.3 C) for noncondensing furnaces and boilers and condensing boilers and may exceed 80°F or fall below 65°F for condensing furnaces. Room temperature (T_{RA}) shall be the arithmetic average temperature of the test area, determined by measurement with four No. 24 AWG iron-constantan bead-type thermocouples with junctions shielded against radiation, located approximately at 90-degree positions on a circle circumscribing the furnace or furnace enclosure under test, in a horizontal plane approximately at the vertical midpoint of the appliance or test enclosure, and with the junctions approximately 24 inches from sides of the furnace or test enclosure and located so as not to be affected by other than room air. The temperature of the air for combustion and the air for draft relief shall not differ more than ±5°F from room temperature as measured above.

20. Section 2.10 of Appendix N to Subpart B is amended to read as follows:

2.10 *Equipment used to measure mass flow rate in flue and stack.* The tracer gas chosen for this task should have a density which is less than or approximately equal to the density of air. Use a gas that is of a different chemical species or different concentration from the flue gas to be measured and unreactive with the environment to be encountered. Using instrumentation of either the batch or continuous type, measure the concentration

of tracer gas with an error no larger than ±2 percent of the value of the concentration measured.

21. Section 3.1.1 of Appendix N to Subpart B is amended to read as follows:

3.1.1 Gas-fueled gravity furnaces, forced-air central furnaces, and low pressure steam and hot water boilers (including direct vent systems and not including condensing furnaces, or boilers). The following procedure is to be used for gas-fueled gravity furnaces, forced-air central furnaces, and boilers (including direct vent systems).

Set up the furnace or boiler as specified in sections 2.1, 2.2, and 2.3. Begin the steady state performance test by operating the burner and the circulating air blower or water pump, with the adjustments specified by 2.4.1 and 2.5, until steady state conditions are attained as indicated by a temperature variation in three successive readings taken 15 minutes apart of not more than: (1) 3°F (1.7C) in the stack gas temperature for furnaces and boilers equipped with draft diverters, (2) 5°F (2.8C) in the flue gas temperature for furnaces and boilers equipped with either draft hoods, or direct vent systems, and (3) 4°F (2.2C) in the outlet water temperature for hot water boilers.

On units employing draft diverters, measure the room temperature (T_{RA}) as described in 2.9 and measure the steady state stack gas temperature ($T_{S.SS.X}$) using the thermocouple grid located in the 5-foot test stack as described in 2.6.1. Secure a sample of stack gases in the plane where $T_{S.SS.X}$ is measured, or within 3.5 feet of this plane on the downstream side, and determine the concentration by volume of carbon dioxide ($X_{CO^2,S}$) present in dry stack gas. If the location of gas sampling differs from the temperature measurement plane, care should be taken to assure that there are no air leaks in the stack pipe between the two locations.

On units employing draft hoods or direct vent systems, measure the room temperature (T_{RA}) as described in 2.9 and measure the steady state flue gas temperature ($T_{F.SS.X}$) using the thermocouple grid located in the flue pipe as described in section 2.6.1. Secure a sample of the flue gas in the plane of temperature measurement and determine the concentration by volume of CO_2 ($X_{CO^2,F}$) present in dry flue gas. For units employing draft hoods or direct vent units which significantly preheat the incoming combustion air, secure a sample of the flue gas in the plane of temperature measurement and determine the concentration by volume of CO_2 ($X_{CO^2,F}$) present in dry flue gas. For direct vent units which do not significantly preheat the incoming combustion air, secure a sample of the flue gas in the plane of temperature measurement, or within 3.5 feet of this plane on the downstream side, and determine the concentration by volume of CO_2 ($X_{CO^2,F}$) present in dry flue gas. If the location of gas sampling differs from the temperature measurement plane, care should be taken to assure that there are no air leaks in the flue pipe between the two locations.

Determine the steady state heat imput rate (Q_{in}), including pilot gas, by multiplying the measured higher heating value of the test gas by the steady state gas input rate corrected to standard conditions of 60°F and 30 inches of mercury. Use measured values of gas temperature and pressure at the meter and the barometric pressure to correct the metered gas flow rate to standard conditions.

Measure the steady state electric power to the power burner (PE) on units so equipped. For furnaces, measure the steady state electrical power to the conditioned air blower (BE). For hot water boilers, use a steady state water pump power of 0.13kW.

After the above test measurements have been completed on units employing integral draft diverters, secure a sample of the flue gases at the inlet to the draft diverter and determine the concentration of CO_2 ($X_{CO^2,F}$) present. In obtaining this sample of flue gas, move the sampling probe around to assure that an average value is obtained for the CO_2 concentration. To obtain the average CO_2 concentration for units with multiple heat exchanger outlets, draw and weigh a sample from each outlet. Block the draft diverter relief opening and cover the draft diverter and flue gas collection box (on a power vented unit) with insulation having an R value no less than 7 (°F-HR-ft²/Btu) and an outer layer of aluminum foil. If the unit is turned off during the process of blocking the diverter relief opening, run it until steady state conditions (as defined above) are again achieved. Progressively restrict the test stack outlet until the concentration of CO_2 in flue gas samples secured from the test stack in the plane where $T_{S.SS.X}$ was measured or within 3.5 feet of this plane on the downstream side, is within ±0.2 percentage points of the previously determined value of ($X_{CO^2,F}$). Measure the flue gas temperature ($T_{F.SS}$) using the thermocouple grid located in the 5-foot test stack as described in 2.6.1.

22. Section 3.1.2 of Appendix N to Subpart B is amended to read as follows:

3.1.2 Oil-fueled forced-air central furnaces and low pressure steam and hot water boilers (including direct vent systems and not including condensing furnaces or boilers). Set up and adjust the furnace or boiler as specified in sections 2.1, 2.2 and 2.3.4. Begin the steady state performance test by operating the burner and the circulating air blower or water pump with the adjustments specified by 2.4.2 and 2.5 until steady state conditions are attained as indicated by a temperature variation in three successive readings taken 15 minutes apart of not more than: (1) 5°F (2.8C) in the flue gas temperature for furnaces and boilers and (2) 4°F (2.2C) in the outlet water temperature for hot water boilers.

Smoke in the flue for units equipped with power burners may not exceed a No. 1 smoke during the steady state performance test as measured by the procedure described in ANSI Standard Z11.182–1975 (R1971) (ASTM D 2156–65 (1970)). Maintain the average draft (recommended by the manufacturer) over the fire and in the breeching during the steady state performance test. Draft fluctuations may not exceed 0.005 inches of water guage.

Measure the room temperature (T_{RA}) as described in 2.9 and measure the steady state flue gas temperature ($T_{F,SS}$) using the thermocouple grid located in the flue pipe as described in 2.6.1. Secure a sample of the flue gas in the plane of temperature measurement or within 3.5 feet of this plane on the downstream side and determine the concenitration by volume of CO_2 ($X_{CO^2,F}$) present in dry flue gas. If the location of gas sampling differs from the temperature measurement plane, care should be taken to assure that there are no air leaks in the flue pipes between the two locations.

Measure and record the steady state heat imput rate (Q_{in}) and the steady state electrical power to the power burner (PE) on unit so equipped. For furnaces, measure the steady state electrical power to the conditioned air blower (BE). For hot water boilers, use a steady state water pump power of BE=0.13 kW.

23. Appendix N to Subpart B is amended by renumbering the present section 3.1.3 as 3.1.4.

24. Appendix N to Subpart B is amended by renumbering the present section 3.1.3 as 3.1.5.

25. Appendix N to Subpart B is amended by adding a new section 3.1.3 to read as follows:

3.1.3 Gas- and oil-fueled condensing furnaces and boilers. The furnace or boiler shall be set up as specified in sections 2.1, 2.2, 2.3, and 2.6. Begin the test by operating the burner and circulating air blower or water pump for hot water boilers, with the adjustments specified in 2.4 and 2.5, until steady state conditions are obtained as indicated by a temperature variation in their successive readings taken 15 minutes apart of not more than 1°F (0.56°C) in the flue gas temperature and the supply (outlet) water temperature.

Measure the room temperature (T_{RA}) as described in section 2.9, and measure the steady state flue gas temperature ($T_{F.SS}$) using the thermocouple grid described in section 2.6. A sample of the flue gas shall be secured in the plane of temperature measurement or within 3.5 feet of this plane on the downstream side and analyzed to determine the concentration by volume of CO_2 ($X_{CO2,F}$) present in the dry flue gas. If the location of sampling the CO_2 differs from the temperature measurement plane, care should be taken to assure that there are no air leaks in the flue pipe between these two locations.

The steady state heat imput rate (Q_{in}), including pilot gas input if appropriate, shall be determined by multiplying the measured higher heating value of the test fuel by the measured steady state imput rate. If gas is the fuel used, correct the imput rate to standard conditions of 69°F and 30 inches of mercury using measured values of gas temperature and pressure at the meter and the measured barometric pressure.

Measure the steady electric power to the burner (PE), if appropriate. For furnaces, measure the steady state electrical power to the conditioned air blower (BE). For hot water boilers, use a steady state water pump power of BE = 0.13 kw. Record all measured values.

26. Section 3.2.1 of Appendix N to Subpart B is amended to read as follows:

3.2.1 Gas- and oil-fuel gravity and forced-air central furnaces (including direct vent systems but not including condensing furnaces). Turn off the main burner after steady state testing is completed and measure the flue gas temperature by means of the thermocouple grid described above at 1.5 ($T_{F.\ OFF}$ (t_3)) and 9.0 minutes ($T_{F.OFF}$ (t_4)) after the burner shuts off. By-pass the damper control in units employing stack dampers and integral draft diverters or draft hoods so that the damper remains open during the cool down test.

During this off-period, allow a time delay (t^+) between burner shut-down and blower shut-down of either 3 minutes or until the supply air temperature drops to a value of 40° F (22.2° C) above the inlet air temperature, whichever results in the longest blower on-time. However, if the furnace employs a single motor to drive a power burner and an indoor air circulating blower, turn off the blower and the burner together. If the blower delay time exceeds 3 minutes, measure the time delay (t^+) between burner shut-off and blower shut-off using a stop watch. The quantity t^+ shall be set equal to this measured delay time or 13.3 minutes, whichever is smaller. For oil-fueled furnaces not equipped with stack dampers, maintain the draft in the flue pipe within a range of −0.001 and +0.005 inch of water gauge of the average draft maintained during the steady state test described in section 3.1 if the optional test in section 3.6 is being carried out, or within ±0.01 inch of water gauge of the average steady state draft if it is not. For a direct vent system with a flue damper or a furnace equipped with both a stack damper and a barometric damper, close the flue or stack damper during the cool-down test. Keep the main burner(s) off until equilibrium conditions are attained as indicated by variations in the flue gas temperature of not more than 3° F (1.7° C) between three successive readings taken 15 minutes apart. For units employing a continuously burning pilot light, take a third flue gas temperature measurement and determine the off-period minimum flue gas temperature ($T_{F.\ OFF}(\infty)$). For units not employing a continuously burning pilot light, set ($T_{F.\ OFF}(\infty)$) equal to the room temperature (T_{RA}). During this cool-down test, measure the energy input rate to the pilot light (Q_P), if the unit is so equipped, within an error no larger than ±3 percent. Record all measured values.

27. Section 3.2.2 of Appendix N to Subpart B is amended to read as follows:

3.2.2 Gas- and oil-fueled boilers (including direct vent systems and not including condensing boilers). After steady state testing has been completed, turn the main burner(s) off and measure the flue gas temperature at 3.75 ($T_{F.\ OFF}(t_3)$) and 22.5 ($T_{F.\ OFF}(t_4)$) minutes after the burner shuts off, using the thermocouple grid described above. During this off-period, do not allow water to circulate through the hot water boilers. Make a third flue gas temperature measurement 45 minutes after the burner shuts off to determine the off-period minimum flue gas temperature ($T_{F.\ OFF}(\infty)$). During this cool-down test, measure the energy input rate to the pilot light (Q_P), if the unit is so equipped, to within an error no larger than ±3 percent. Record all measured values. For oil-fueled units not equipped with stack dampers, maintain the draft in the flue within the same ranges called for in section 3.2.1 above. For direct vent systems with flue dampers or boilers equipped with both stack dampers and barometric dampers, close the flue or stack damper during the cool-down test.

28. Appendix N to Subpart B is amended by adding, after section 3.2.2, the following new sections:

3.2.3 Gas- and oil-fueled condensing furnaces. After steady state testing is completed and all required measurements made, the burner shall be turned off and the flue gas temperature measured by means of the thermocouple grid described in section 2.6 at 1.5 ($T_{F.\ OFF}$ t_3) and 9.0 ($T_{F.\ OFF}$ t_4) minutes after the burner shuts off. Units employing flue dampers shall have their dampers closed during the cool-down test. During this off-period, there shall be a time delay (t^+) between burner shut down and blower shut-down of either 1.5 minutes or until the supply air temperature drops to a value of 40° F (22.2° C) above the inlet air temperature, whichever results in the larger blower on-time. An exception to this is if the furnace employs a single motor to drive a power burner and an indoor air circulating blower, the blower and the burner shall be shut off together. If the blower delay time exceeds 1.5 minutes, the time between burner shut-off and blower shut-off shall be measured using a stop watch and the quantity t^+ shall be set equal to this measured delay time or 13.3 minutes, whichever is smaller. For units equipped with a continuously burning pilot light, the main burner(s) shall remain off until equilibrium conditions are attained as indicated by variations in the flue gas temperature of not more than 0.5° F (0.28° C) in three successive readings taken 15 minutes apart, and then a third flue gas temperature measurement shall be made to determine the off-period minimum flue gas temperature ($T_{F.\ OFF}(\infty)$). For units not equipped with a continuously operating pilot light, $T_{F.\ OFF}(\infty)$ shall be set equal to the measured room temperature (T_{RA}) and the unit shall remain off for a minimum time period of 20 minutes.

During the cool-down test, the energy input rate to the pilot light (Q_P), if the unit is so equipped, shall be measured with an error no larger than ±3 percent. Record all measured values.

3.2.4 Gas- and oil-fueled condensing boilers. After steady state testing is completed, the main burner(s) shall be turned off and the flue gas temperature measured at 3.75 ($T_{F.\ OFF}(t_3)$) and 22.5 ($T_{F.\ OFF}(t_4)$) minutes after the burner(s) shuts off, using the thermocouple grid described in section 2.6. During this off-period, no water shall be allowed to circulate through the boiler. A third flue gas temperature shall be made 45 minutes after the burner(s) shuts off to determine the off-period minimum flue gas temperature ($T_{F.\ OFF}(\infty)$). During this cool-down test, the energy input rate to the pilot light (Q_P), if the unit is so equipped, shall be measured with an error no larger than ±3 percent. For units equipped with flue dampers, the damper shall be closed during the cool-down test. Record all measured values.

29. Section 3.3.1 of Appendix N to Subpart B is amended to read as follows:

3.3.1 Gas- and oil-fueled central furnaces (including direct vent systems and not including condensing furnaces). After equilibrium conditions are achieved following the cool-down test and the required measurements performed, turn on the furnace and measure the flue gas temperature using the thermocouple grid described above, at 0.5 ($T_{F.\ ON}(t_1)$) and 2.5 ($T_{F.\ ON}(t_2)$) minutes after the main burner(s) comes on. After the burner start-up, delay the blower start-up by 1.5 minutes (t^-) unless: (1) the furnace employs a single motor to drive the power burner and the indoor air circulating blower, in which case the burner and blower shall be started together, or (2) the delay time would result in the activation of a temperature safety device which shuts off the burner, in which case the fan control shall be permitted to start the blower. In the latter case, if the fan control is adjustable, set it to start the blower at the highest temperature. If the fan control is permitted to start the blower, measure the time delay (t^-) using a stop watch. Record the measured temperatures. During the heat-up test for oil-fueled furnaces, maintain the draft in the flue pipe within ±0.01 inch of water gauge of the manufacturer's recommended on-period draft.

30. Section 3.3.2 of Appendix N to Subpart B is amended to read as follows:

3.3.2 Gas- oil-fueled boiler (including direct vent systems and not including condensing boilers). Fifty minutes after the main burner(s) is turned off for the cool-down test, turn on the steam or hot water boiler and measure the flue gas temperature using the thermocouple grid described above, at 1.0 ($T_{F.\ ON}(t_1)$) and 5.5 ($T_{F.\ ON}(t_2)$) minutes after the main burner(s) comes on. Start the pump circulating the water through the hot water boiler simultaneously with the main burner(s) and maintain the water flow rate at that maintained during the steady state test described in section 3.1. During the heat-up test for oil fired boilers, maintain the draft in the flue pipe within ±0.01 inch of water column of the manufacturer's recommended on-period draft. Record the measured temperatures.

31. Appendix N to Subpart B is amended by adding, at the end of section 3.3.2, the following new sections:

3.3.3 Gas- and oil-fueled condensing furnaces. After the cool-down test is completed, the furnace shall be turned on and the flue gas temperature measured using the thermocouple grid described in section 2.6 at 0.5 ($T_{F.\ ON}(t_1)$) and 2.5 ($T_{F.\ ON}(t_2)$) minutes after the main burner(s) comes on. During this on-period, there shall be a time delay (t^-) between the burner start-up and blower start-

up of 1.5 minutes. Two exceptions to this are: (1) if the furnace employs a single motor to drive a power burner and an indoor air circulating blower, both shall be started together, and (2) if a 1.5 minute blower delay time results in the operation of the high limit control to shut the burner off, the fan control shall be permitted to automatically start the blower provided, if it is adjustable, it is set to turn the blower on at the highest flue gas temperature. If the fan control is permitted to start the blower, the time delay (t^-) between burner and blower start-up shall be measured using a stop watch. Record the measured values.

3.3.4 Gas- and oil-fueled condensing boilers. Fifty minutes after the main burner(s) is turned off for the cool-down test, the condensing boiler shall be turned on and the flue gas temperature measured using the thermocouple grid described in section 2.6 at 1.0 ($T_{F,\,ON}(t_1)$) and 5.5 ($T_{F,\,ON}(t_5)$) minutes after the main burner comes on. The pump circulating the water through the boiler shall be started simultaneously with the main burner(s), the water flow rate shall be the same as that maintained during the steady state test described in 3.1, and the return water temperature shall be within the limits specified in section 2.5.4.

32. Section 3.4(i) and (ii) of Appendix N to Subpart B is amended to read as follows:

(i) Electric and gas-fueled gravity and forced-air central furnaces—ANSI Standard Z21.47–1978, section 2.12.1 and Exhibit B.

(ii) Gas- and oil-fueled low pressure steam and hot water boilers—ANSI Z21.47–1978 section 2.12.1 and Exhibit B.

33. The first two sentences of 3.6 of Appendix N to Subpart B are amended to read as follows:

3.6 *Optional procedure for determining D_P, D_R, and D_S for systems equipped with power burners, forced draft fans, induced draft fans and for direct vent systems with nonpowered burners.* On systems which employ power burners, forced draft fans, or induced draft fans and do not employ a stack damper, or do employ a stack damper but with a draft diverter or draft hood, and direct vent system measure D_f (the ratio of gas mass flow rate through the flue during the off-cycle to the gas mass flow rate through the flue during the on-cycle at identical temperatures) during the cool-down test described in section 3.2.

* * * * *

34. Appendix N to Subpart B is amended by adding the following new paragraph at the end of section 3.6:

* * * * *

For any unit whose design is such that there is no air flow through the combustion chamber and heat exchange during the off period, D_f and D_p shall be set equal to 0.0. For condensing units employing power burners, forced draft fans, or induced draft fans, the values of D_f and D_p may be obtained using the optional procedures described above in this section, except that the steady state conditions shall be indicated by a temperature variation in three successive readings, taken 15 minutes apart, of not more more than 1°F in the flue gas temperature in the case of furnaces and the supply (outlet) water temperature for hot water boilers.

35. Appendix N to Subpart B is amended by adding after section 3.6, the following new section:

3.7 *Optional procedure for condensing furnaces and boilers which have no off-period flue losses.* At the discretion of the manufacturer, the cool-down and heat-up tests specified in 3.2 and 3.3 may be omitted on condensing units for which there is no air flow through the combustion chamber and heat exchange during the off period. In lieu of conducting the cool-down and heat-up tests, the manufacture may use the losses determined during the steady state test described in 3.1 when calculating part load efficiency (η_u).

36. Section 4.2.2 of Appendix N to Subpart B is amended to read as follows:

4.2.2 Ratio of combustion air to stoichiometric air. Determine the ratio of combustion air mass flow rate to stoichiometric air mass flow rate ($R_{T,F}$) for the test fuel from Figure 1 by using the value of dry flue gas CO_2 concentration ($X_{CO_2,F}$) determined in accordance with section 3.1 of this appendix.

37. Section 4.2.5 of Appendix N to Subpart B is amended to read as follows:

4.2.5 Steady state efficiency. Calculate the steady state efficiency (excluding jacket loss) (η_{ss}) expressed in percent and defined as:

$\eta_{ss} = 100 - C'_L L_{L,A} - L_{S,SS,A} - L'_C$, for noncondensing furnaces and boilers and condensing furnaces

and

$$\eta_{ss} = 100 - L_{L,A} - L_{s,ss,A} - \frac{(100)(.24)(180-120)\left[1+(R_{T,F})(A/F)\right]}{HHV_A}, \text{ for condensing boilers}$$

where:

$L_{L,A}$ = average latent heat loss of the test fuel determined in accordance with Table 3, in percent.

$L_{S,SS,A}$ as defined in 4.2.4.

(.24) = specific heat of air.

(180) = rated return water temperature.

(120) = test return water temperature.

$R_{T,F}$ as defined in 4.2.2.

A/F = the stoichiometric air/fuel ratio determined in accordance with table 3.

100 = number which relates results in percentages.

HHV_A = average higher heating value of the test fuel determined in accordance with Table 3, in Btu's per pound.

L'_C=0 for non-condensing furnaces or boilers and as determined in 4.2.33 for condensing furnaces or boilers.

C'_L=1 for non-condensing furnaces or boilers and as determined in 4.2.33 for condensing furnaces or boilers.

38. Section 4.2.6 of Appendix N to Subpart B is amended to read as follows:

4.2.6 Average ratio of stack gas mass flow rate to flue gas mass flow rate at full-load steady state operation. Determine the average ratio of stack gas mass flow rate to flue gas mass flow rate at full-load steady state operation (S/F) for the system number to be tested from table 1 or 2.

39. Appendix N to Subpart B is amended by adding in the equation in section 4.2.8 a minus sign, "—", between the two terms of the numerator.

40. Appendix N to Subpart B is amended by changing the fourth and fifth paragraphs of section 4.2.13 to read:

D_P=off-cycle flue gas draft factor selected from table 1 or, for units with power burners, induced draft fans, or forced draft fans where D_p is measured, determined in accordance with section 4.4.2 of this appendix.

D_S=off-cycle stack gas draft factor selected from table 1 or, for units with power burners, induced draft fans, or forced draft fans where D_P is measured, determined in accordance with section 4.4.3 of this appendix.

41. Section 4.2.15 of Appendix N to Subpart B is amended to read as follows:

4.2.15 Correction factors for systems 9–12. Calculate a correction factor which corrects for the use of outdoor air for combustion instead of air at room temperature (C_s) defined as:

for non-condensing furnaces:

$$C_s = 1 + \frac{(70-42)\,\eta_{ss}}{(T_{F,SS}-T_{RA})\,100}$$

for condensing furnaces:

$$C_s = \frac{T_{F,SS}-42}{T_{F,SS}-70}$$

42 = average outdoor temperature corresponding to 5,200 degree day location, in degrees fahrenheit.
η_{ss} as defined in 4.2.5.
$T_{F,ss}$ as defined in 4.2.4.
70 assumed average indoor air temperature.
T_{RA} as defined in 4.2.4.

The correction factor which corrects for the effect of outdoor air passing through the heat exchanger during the off-period, C'_e is defined as: $C'_e = 1.22$

42. Appendix N to Subpart B is amended by changing the second paragraph of section 4.2.22 to read as follows:

For systems 1–8 and condensing units:
* * *

43. Appendix N to Subpart B is amended by changing the third paragraph of section 4.2.22 to read as follows:

For systems 9–12 except condensing units:
* * *

44. Appendix N to Subpart B is amended by changing section 4.2.32 to read as follows:

4.2.32 Latent heat loss coefficient (C_L). For condensing furnaces, and for part load and steady state conditions, calculate the latent heat loss coefficient expressed as a decimal and defined as:
for part load conditions

$$\text{If } P_V > P_V^S$$

$$C_L = \frac{P_V^S}{P_V} \times \frac{14.7 - P_V}{14.7 - P_V^S}$$

$$\text{If } P_V \leq P_V^S$$

$$C_L = 1.0$$

for steady-state conditions

$$\text{If } P_V > P_V^{S,ss}$$

$$C_L' = \frac{P_V^{S,ss}}{P_V} \times \frac{14.7 - P_V}{14.7 - P_V^{S,ss}}$$

$$\text{If } P_V \leq P_V^{S,ss}$$

$$C_L = 1.0$$

where:

$$P_V = \frac{M_V}{M_{FG}} \times \frac{m_{FG}}{m_V} \quad (14.7),$$

is the water vapor partial pressure that would be in the flue gases if there were no condensation and the atmospheric pressure were equal to 14.7 psia.
14.7 = standard atmospheric pressure in psia.
$M_V = 18$, is the approximate molecular weight of water.
M_{FG} =
29.0 for No. 1 and No. 2 fuel oil
28.0 for natural gas
27.5 for manufactured gas
28.5 butane and propane, are the approximate apparent molecular weights of flue gases for different fuels.

$$m_{FG} = 1 + \left[(A/F) \quad (R_{T,F})\right]$$

is the weight of flue gases generated per unit weight of fuel burnt.

$$m_V = \frac{(HHV_A) \quad (L_{L,A})}{(100) \quad (1053.3)}$$

(HHV_A) as defined in 4.2.5
$(L_{L,A})$ as defined in 4.2.5
(A/F) as defined in 4.2.5
$(R_{T,F})$ as defined in 4.2.5
(1053.3) is assumed latent heat/lb. of water
P_V^S = saturated vapor pressure determined from Table 5 at average flue gas temperature $\bar{T}_{F,ON}$.
$P_V^{S,SS}$ = saturated vapor pressure determined from Table 5 at average flue gas temperature at full-load steady-state operation $T_{F,SS}$.
where:
If the option described in 3.7 is not employed:

$$\left[T_{F,ON} - T_{F,SS}\right] = \frac{\theta_{F,O}}{(t_{ON}/\tau_{ON})}\left[1 - e^{-(t_{ON}/\tau_{ON})}\right]$$

If the option described in 3.7 is employed: $\bar{T}_{F,ON} = T_{F,SS}$

where:
$T_{F,SS}$ as defined in 4.2.4.
$\theta_{F,O}$ as defined in 4.2.22.
t_{ON} as defined in 4.2.20.
τ_{ON} as defined in 4.2.20.

45. Appendix N to Subpart B is amended by renumbering existing section 4.2.33 to 4.2.35.

46. Appendix N to Subpart B is amended by adding a new section 4.2.33 to read as follows:

4.2.33 Condensate heat loss. For condensing furnaces, and for part load and steady state conditions calculate the loss due to condensate going down the drain and correct for the fact that this condensate did not go up the flue as heated vapor (as was assumed in determining $L_{s,ss,A}$), expressed as a percent and defined as:
for part load conditions:

$$L_C = \frac{L_{L,A}(1 - C_L)\left[1.0(T_{F,SS} - 70) - .45(T_{F,SS} - 42)\right]}{1053.3}$$

for steady steady state conditions:

$$L_C' = \frac{L_{L,A}(1 - C_L')\left[1.0 \quad (T_{F,ss} - 70) - .45 \quad (T_{F,ss} - 42)\right]}{1053.3}$$

where:

$T_{F,SS}$ as defined in 4.2.4.
.45 specific heat of water vapor
1.0 specific heat of water (liquid)
70 as defined in 4.2.15
42 as defined in 4.2.15
C_L as defined in 4.2.32
C'_L as defined in 4.2.32
$L_{L,A}$ as defined in 4.2.5
1053.3 latent heat vaporization of water

$$\eta_U = 100 - C_L L_{L,A} - L_C - C_J L_J - \frac{t_{on}}{t_{on} + \frac{Q_p}{Q_{NP}}(t_{off})} \left(Q_{NP}\right) \left[L_{S,ON} + L_{S,OFF} + L_{L,ON} + L_{L,OFF}\right]$$

If the option described in 3.7 is employed:

$$\eta_U = 100 - C'_L L_{L,A} - L_C - C_J L_J - \frac{t_{on}}{t_{on} + \frac{Q_p}{Q_{NP}}(t_{off})} \left[C_S L_{S,SS,A}\right] \left(Q_{NP}\right)$$

where:

C_J=0 for furnaces or boilers intended to be installed indoors, 3.3 for furnaces intended to be installed outdoors, and 4.7 for boilers intended to be installed outdoors.
C_S as defined in 4.2.15.
C_L=1 for non-condensing furnaces or boilers, and as determined in 4.2.32 for condensing furnaces or boilers.
t_{on} as defined in 4.2.20.
t_{off} as defined in 4.2.21.
Q_p=pilot flame fuel input rate determined in accordance with section 3.2 of this Appendix, in Btu's per hour.
Q_{NP}=nameplate input rating as defined in 1.31.
L_J=jacket loss determined in accordance with section 3.4 of this Appendix, in percent.
$L_{L,A}$ as defined in 4.2.5.
t_{on} as defined in 4.2.20.
t_{off} as defined in 4.2.21.
$L_{s,on}$ as defined in 4.2.28.
$L_{s,off}$ as defined in 4.2.29.
$L_{l,on}$ as defined in 4.2.30.
$L_{l,off}$ as defined in 4.2.31.
$L_{S,SS,A}$ as defined in 4.2.4.
L_C=0 for non-condensing furnaces or boilers, and as determined in 4.2.33 for condensing furnaces or boilers.

47a. Appendix N to Subpart B is amended by changing in section 4.2.35, 4.8 and 4.12 the term Q_{in} to Q_{NP} in all formulas and replacing the expression "Q_{in}" as defined in 4.2.32" to Q_{NP} as defined in 1.31.

48. Appendix N to Subpart B is amended by changing in sections 4.4.1, 4.4.2, 4.4.3, and 4.5, the words "power burner" to "power burner, induced draft fan or forced draft fan."

49. Section 4.4 of Appendix N to Subpart B is amended by adding a paragraph at the end of the section to read as follows:

* * * * *

For direct exhaust systems utilizing indoor air for combustion and employing forced or induced draft shall be tested as a direct vent system without preheating of combustion air. The test data for the type of furnace shall be reduced as a system number 2 with S/F=1, and $D_s=D_f=0.4$ or D_p if the unit is not equipped with a flue damper, and as a system number 8 with S/F=1, $D_f=0.4$ or D_p, and $D_s=(0.4)\ D_o$ or $(D_p)\ (D_s)$, if the unit is equipped with a flue damper.

50. Appendix N to Subpart B is amended by changing the fourth paragraph of section 4.7 to read as follows:

$Q_{out}=(\eta_{ss}/100)$ (nameplate input) rounded off to the nearest 1,000 Btu/hr for units intended for installation in a heated space, $Q_{out}=(\eta_{ss}/100—(3.3)\ (L_J/100))$ (nameplate input) rounded off to the nearest 1,000 Btu/hr for units intended for installation outdoors or in an unheated space, and $Q_{out}=(\eta_{ss}/100)—(L_J/100)$ (nameplate input) rounded off to the nearest 1,000 Btu/hr for finned tubed boilers intended for installation outdoors or in an unheated space.

51. Appendix N to Subpart B is amended by changing in section 4.7 the defined term "O_{ss} as defined in 4.2.5" to "η_{ss} as defined in 4.2.5."

52. Appendix N to Subpart B is amended by changing the cite "4.2.32" in section 4.7 to "4.2.34."

53. Appendix N to Subpart B is amended by adding at the end of section 4.7 the defined term:

. nameplate input as defined in section 1.31.

53a. Appendix N in Subpart B is amended by replacing the existing formula for $E_{F,R}$ to:

$E_{F,R}=(Q_{in}-Q_P)\ BOH+8760\ Q_P$

54. Appendix N to Subpart B is amended by adding a new section 4.15 after existing section 4.14 to read as follows:

4.15 *Energy factor for furnaces.*

Calculate the energy factor for gas and oil-fueled furnaces*, EF, defined as:

$$E_F = \left[\frac{(\eta_u/100)\left[E_F - (4600\ Q_p)\right]}{E_F + 3413\ E_{AE}}\right] (100)$$

Where:

η_u is the part-load fuel utilization-efficiency defined in 4.2.34.

E_F is the average annual fuel energy consumption as defined in section 4.8.

4600 as defined in 4.2.35.

Q_P as defined in 4.2.35.

E_{AE} is the average annual auxiliary electric energy consumption as defined in 4.9.

3413 conversion factor corresponding to 1 kilowatt=3414 Btu/hour.

*Set the energy factor for electric-furnaces equal to the annual fuel utilization-efficiency as defined in 4.1.

55. Appendix N to Subpart B is amended by changing the title of Table 1 to read as follows:

Factors Describing Air Flow Rate for Gas- and Oil-Fired Non-Condensing Furnaces or

Boiler Utilizing Indoor Air for Combustion and Draft Control.

56. Appendix N to Subpart B is amended by adding to the title of Table 2 the phrase "and All Condensing Furnaces or Boilers" at the end of the existing title.

57. Appendix N to Subpart B is amended by adding to Table 4 the following line items preceding the existing line items:

5,000 to 10,000	5	5
11,000 to 16,000	10	5, 10
17,000 to 25,000	15	10, 15

58. Appendix N to Subpart B is amended by adding a new Table 5 after existing Table 4 to read as follows:

Table 5.—*Saturated Vapor Pressure at Different Temperatures*

	Pressure (lb./in²a)
Temperature (°F):	
700	3094.3
600	1543.2
500	680.86
400	247.259
300	67.005
200	11.526
180.0	7.5110
179.0	7.3460
178.0	7.1840
177.0	7.0250
176.0	6.8690
175.0	6.7159
174.0	6.5656
173.0	6.4182
172.0	6.2736
171.0	6.1318
170.0	5.9926
169.0	5.8562
168.0	5.7223
167.0	5.5911
166.0	5.4623
165.0	5.3361
164.0	5.2124
163.0	5.0911
162.0	4.9722
161.0	4.8556
160.0	4.7414
159.0	4.6294
158.0	4.5197
157.0	4.4122
156.0	4.3068
155.0	4.2036
154.0	4.1025
153.0	4.0035
152.0	3.9065
151.0	3.8114
150.0	3.7184
149.0	3.6273
148.0	3.5381
147.0	3.4508
146.0	3.3653
145.0	3.2816
144.0	3.1997
143.0	3.1195
142.0	3.0411
141.0	2.9643
140.0	2.8892
139.0	2.8157
138.0	2.7438
137.0	2.6735
136.0	2.6047
135.0	2.5375
134.0	2.4717
133.0	2.4074
132.0	2.3445
131.0	2.2830
130.0	2.2230
129.0	2.1642
128.0	2.1068
127.0	2.0507
126.0	1.9959
125.0	1.9424
124.0	1.8901
123.0	1.8390
122.0	1.7891
121.0	1.7403
120.0	1.6927
119.0	1.6463
118.0	1.6009
117.0	1.5566
116.0	1.5133
115.0	1.4711
114.0	1.4299
113.0	1.3898
112.0	1.3505
111.0	1.3123
110.0	1.2750
109.0	1.2385
108.0	1.2030
107.0	1.1684
106.0	1.1347
105.0	1.10174
104.0	1.0338
103.0	1.06965
102.0	1.00789
101.0	0.97818
100.0	0.94924
99.0	0.92103
98.0	0.89356
97.0	0.86679
96.0	0.84072
95.0	0.81534
94.0	0.79062
93.0	0.76655
92.0	0.74313
91.0	0.72032
90.0	0.69813
89.0	0.67653
88.0	0.65551
87.0	0.63507
86.0	0.61518
85.0	0.59583
84.0	0.57702
83.0	0.55872
82.0	0.54093
81.0	0.52364
80.0	0.50683
79.0	0.49049
78.0	0.47461
77.0	0.45919
76.0	0.44420
75.0	0.42964
74.0	0.41550
73.0	0.40177
72.0	0.38844
71.0	0.37549
70.0	0.36292
69.0	0.35073
68.0	0.33889
67.0	0.32740
66.0	0.31626
65.0	0.30545
64.0	0.29497
63.0	0.28480
62.0	0.27494
61.0	0.26538

[FR Doc. 80-24188 Filed 8-11-80; 8:45 am]

BILLING CODE 6450-01-M